

REMARKS

The Office Action dated June 30, 2008 has been received and carefully noted.

The above amendments and the following remarks are being submitted as a full and complete response thereto. Reconsideration of this application is respectfully requested in view of the foregoing amendment and the following remarks.

Summary of the Office Action

In the outstanding Office Action dated June 30, 2008, the disclosure was objected to for its use of "mmaq" as differential pressure units. The Examiner points out that the abstract should not exceed 150 words. Further, claims 1, 4 and 5 were objected to for informalities. Claims 1 and 4 were rejected under 35 U.S.C. § 103(a) as being unpatenable over U.S. Patent 6,821,661 to Haridoss et al. (hereinafter, "Haridoss") in view of U.S. Patent Application Publication 2002/0064699 to Fukuda et al. (hereinafter, "Fukuda") and U.S. Patent Application Publication 2002/0068213 to Kaiser et al. (hereinafter, "Kaiser"). Claim 2 was rejected under 35 U.S.C. § 103(a) as being unpatentable over Haridoss, Fukuda and Kaiser further in view of U.S. Patent No. 6,280,871 to Tosco et al. (hereinafter, "Tosco") and U.S. Patent No. 6,083,638 to Taniguchi et al. (hereinafter, "Taniguchi"). Claim 3 was rejected under 35 U.S.C. § 103(a) as being unpatentable over Haridoss, Fukuda and Kaiser further in view of Tosco. Claims 5 and 6 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Haridoss, Fukuda, Kaiser, Japan Patent Application Publication No. 10-223233 to

Saito (hereinafter, "Saito") and U.S. Patent Application Publication No. 2003/0072991 to Matsubara et al. (hereinafter, "Matsubara").

Summary Response to the Office Action

The Abstract and claims 1, 4 and 5 have been amended in response to the Examiner's objections. Figures 4, 9 and 16 and Tables 1, 3, 4 and 5 have also been amended. Claims 2, 3 and 6 have been left in their original form. Thus, claims 1-6 are currently pending in the application and subject to examination. Because support for the amended claims is provided in the application as originally filed, the Applicants respectfully submit that no new matter is presented herein. To the extent that the rejection(s) remain applicable to the claims currently pending, the Applicants hereby traverse the rejection, as follows.

Informal Matters

In the Office Action mailed dated June 30, 2008, the abstract and claims 1, 4 and 5 were objected to for informalities. The abstract and claims have been amended responsive to the objections. Figures 4, 9 and 16 and Tables 1, 3, 4 and 5 have also been amended to be consistent with changes indicated in the Examiner's objections. If any additional amendment is necessary to overcome the objections and rejection, the Examiner is requested to contact the Applicant's undersigned representative.

Rejection Under 35 U.S.C. § 103(a)

In the outstanding Office Action, claim 1 was rejected under 35 U.S.C. § 103(a) as being unpatentable over Haridoss in view of Fukuda and Kaiser. The Applicants respectfully traverse this rejection, insofar as it applies to newly amended claim 1, because Haridoss, Fukuda and Kaiser, either independently or in combination, fail to teach each and every feature of newly amended independent claim 1. For example, newly amended independent claim 1 recites, amongst other features, “an anode and a cathode each having a catalytic layer and a diffusion layer,” where the anode diffusion layer further comprises “a carbon-based material” with “a water holding layer thereon containing water holding material for 5 to 20 wt% of total weight of an electron conductive material and the water holding material, or carbon particles having water absorption amount at saturated water vapor pressure at 60°C of not less than 150 cc/g, wherein water absorption ratio of the anode diffusion layer at 60°C is in a range of 40 to 85%, wherein a differential pressure of the anode diffusion layer measured by the differential pressure measuring method is in a range of 60 to 120 mmAq, and wherein a ratio of quantity of electric charge of catalytic material of the cathode catalytic layer existing a proton conductive passage from the polymer electrolyte membrane measured by a cyclic voltammetric method is not less than 15% of the quantity of electric charge of all the catalytic material existing in the cathode.” The Applicants respectfully submit that Haridoss, Fukuda and Kaiser, either independently or in combination, fail to teach or suggest at least an anode diffusion layer as claimed in claim 1, much less the very specific features of that diffusion layer claimed in detail in claim 1.

Haridoss does disclose a membrane electrode assembly MEA in FIG. 6. Further, the MEA of Haridoss is disclosed as containing “adjacent catalyst layers” (column 1, lines 55-57) that are surrounded by the two Gas Diffusion Layers GDLs, as shown in FIG. 6. Haridoss also discloses that the GDLs can be composed of “carbon fibers” in column 3 line 33 and “carbon paper or cloth” in column 4 line 48 and that the GDLs may, in some embodiments, have a “layer or coating on the GDL” of hydrophilic material. The Applicants respectfully agree with the Examiner that Haridoss does not teach a water holding layer on the carbon layer with the specifications claimed in claim 1. The Examiner attempts to make up for this deficiency of Haridoss by replacing the “carbon fibers,” “carbon paper or cloth” in the GDL of Haridoss by catalyst carrying carbon black particles of taught in Fukuda. In order to justify this combination of Haridoss and Fukuda, the Examiner states that Fukuda teaches the carbon black particles “in a fuel electrode of a solid polymer fuel cell” and that “it would be obvious” to “use the water holding material of Fukuda” (i.e., the catalyst carrying carbon black particles) “in the water holding layer of Haridoss to ensure the proton conductivity of the electrolyte membrane by maintaining it in a wet state.”

However, as Fukuda states explicitly in paragraph [0013] that the carbon black particles have “catalyst metal carried on [their] surfaces.” The purpose of the carbon black particles of Fukuda, as explained in paragraph [0009], is to replace the catalyst carrying carbon black particles of a particular type of fuel cell known in the art (see paragraph [0004]), with catalyst carrying carbon black particles that have adjusted water retention in order to “avoid the need for polytetrafluoroethylene (PTFE) particles” and, thereby, reduce the thickness of electrodes. In other words, the catalyst carrying

carbon black particles of Fukuda are meant for replacing catalyst carrying carbon black particles in a catalyst layer of an electrode. The catalyst carrying carbon black particles of Fukuda are part of a catalyst layer. Therefore, replacing the “carbon fibers,” “carbon paper or cloth” in the GDL of Haridoss by carbon black particles of Fukuda does not yield the structure claimed in claim 1. Rather, this replacement proposed by the Examiner yields an anode structure that merely substitutes the “carbon fibers,” “carbon paper or cloth” in the GDL by a catalyst layer. This actually renders the GDL a catalyst layer and eliminates a separate diffusion layer, as claimed in claim 1.

The replacement proposed by the Examiner intermingles the catalyst with the carbon layer in the Gas Diffusion Layers GDL of the anode and, therefore, results in a device in which there is no separation between the catalytic layer and the carbon-based diffusion layer. In contrast, claim 1 claims a catalytic layer and a diffusion layer in the anode and specifies further that it is the diffusion layer that comprises a carbon-based material with all of the specific structural details claimed in claim 1. This structure claimed in claim 1 is simply not obtained by replacing the “carbon fibers,” “carbon paper or cloth” in the GDL of Haridoss by the catalyst carrying carbon black particles of Fukuda as that replacement does provides no such carbon-based diffusion layer specified in the claim. In fact, this modification, in an attempt to endow the carbon-based diffusion layer of Haridoss with the structure claimed in claim 1, actually replaces the carbon based diffusion layer of Haridoss with a carbon-based catalytic layer and leaves the device of Haridoss without separate catalyst and diffusion layers, as claimed in claim 1.

The Applicants also respectfully submit that Kaiser, as cited by the Examiner, does not cure the deficiencies of the combination of Haridoss and Fukuda with respect to the anode diffusion layer as claimed in claim 1. Kaiser teaches a multiple layer electrode that includes multiple layers of catalyst (abstract). Although Kaiser does mention that diffusion layer in the electrode may be formed of "carbon fiber paper or cloth" (paragraph [0003]), Kaiser, as cited by the Examiner, does not disclose, teach or otherwise suggest the specific structure of the that the diffusion layer claimed in claim 1. In particular, Kaiser does not teach, disclose or otherwise suggest that the carbon-based material of the diffusion layer comprises a "a water holding layer thereon containing water holding material for 5 to 20 wt% of total weight of an electron conductive material and the water holding material, or carbon particles having water absorption amount at saturated water vapor pressure at 60°C of not less than 150 cc/g, wherein water absorption ratio of the anode diffusion layer at 60°C is in a range of 40 to 85%, wherein a differential pressure of the anode diffusion layer measured by the differential pressure measuring method is in a range of 60 to 120 mmAq, and wherein a ratio of quantity of electric charge of catalytic material of the cathode catalytic layer existing a proton conductive passage from the polymer electrolyte membrane measured by a cyclic voltammetric method is not less than 15% of the quantity of electric charge of all the catalytic material existing in the cathode."

For at least these reasons, Haridoss, Fukuda and Kaiser, either independently or in combination, do not teach or suggest all of the features of newly amended independent claim 1. Moreover, Applicants also respectfully assert that dependent claims 2 and 3 are allowable at least because of their ultimate dependency on newly

amended independent claim 1 and for the additional features that they recite. Accordingly, the Applicants respectfully request that the 35 U.S.C. § 103(a) rejections of the Office Action of June 30, 2008 relating to these claims be withdrawn.

In the outstanding Office Action, claim 4 was also rejected under 35 U.S.C. § 103(a) as being unpatentable over Haridoss in view of Fukuda and Kaiser. The Applicants respectfully traverse this rejection, insofar as it applies to newly amended claim 4, because Haridoss, Fukuda and Kaiser, either independently or in combination, fail to teach each and every feature of newly amended independent claim 4. For example, newly amended independent claim 4 recites, amongst other features, “an anode and a cathode each having a catalytic layer and a diffusion layer,” where the anode diffusion layer further comprises “a carbon-based material having a contact angle with water of not more than 90° by performing a hydrophilic treatment.” Newly amended independent claim 4 also recites, amongst other features, a layer on the a carbon-based material wherein the layer is also part of the diffusion layer and has “carbon particles having water absorption amount at saturated water vapor pressure at 60°C of not less than 150 cc/g and fluorine resin” and “wherein water absorption ratio of the anode diffusion layer at 60°C is in a range of 40 to 85%, wherein penetration resistance measured by a penetration resistance method is not more than 5 mΩ, wherein a differential pressure of the anode diffusion layer measured by the differential pressure measuring method is in a range of 60 to 120 mmAq, and wherein a ratio of quantity of electric charge of catalytic material of the cathode catalytic layer existing in proton conductive passage from the polymer electrolyte membrane measured by a cyclic voltammetric method is not less than 15% of the quantity of electric charge of all the

catalytic material existing in the cathode catalytic layer.” The Applicants respectfully submit that Haridoss, Fukuda and Kaiser, either independently or in combination, fail to teach or suggest at least an anode diffusion layer as claimed in claim 4, much less the very specific features of that diffusion layer claimed in detail in claim 4.

Again, the Examiner attempts to make up for the deficiency of Haridoss with respect to the layer on the carbon-based material having carbon particles with specified water absorption properties by replacing the “carbon fibers,” “carbon paper or cloth” in the GDL of Haridoss by catalyst carrying carbon black particles of taught in Fukuda. However, as argued above and as Fukuda states explicitly in paragraph [0013] that the carbon black particles have “catalyst metal carried on [their] surfaces.” Again, the catalyst carrying carbon black particles of Fukuda are part of a catalyst layer. Therefore, replacing the “carbon fibers,” “carbon paper or cloth” in the GDL of Haridoss by carbon black particles of Fukuda does not yield the structure claimed in claim 4. Rather, this replacement proposed by the Examiner yields an anode structure that merely substitutes the “carbon fibers,” “carbon paper or cloth” in the GDL by a catalyst layer. This actually renders the GDL a catalyst layer and eliminates a separate diffusion layer, as claimed in claim 4.

The replacement proposed by the Examiner also intermingles the catalyst with the carbon layer in the Gas Diffusion Layers GDL of the anode and, therefore, results in a device in which there is no separation between the catalytic layer and the carbon-based diffusion layer. In contrast, claim 4 claims a catalytic layer and a diffusion layer in the anode and specifies further that it is the diffusion layer that comprises a carbon-based material with all of the specific structural details claimed in claim 4. This structure

claimed in claim 4 is simply not obtained by replacing the “carbon fibers,” “carbon paper or cloth” in the GDL of Haridoss by the catalyst carrying carbon black particles of Fukuda as that replacement does provides no such carbon-based diffusion layer specified in the claim. In fact, this modification, in an attempt to endow the carbon-based diffusion layer of Haridoss with the structure claimed in claim 4, actually replaces the carbon based diffusion layer of Haridoss with a carbon-based catalytic layer and leaves the device of Haridoss without separate catalyst and diffusion layers, as claimed in claim 4.

Once again, Kaiser, as cited by the Examiner, does not cure the deficiencies of the combination of Haridoss and Fukuda with respect to the anode diffusion layer as claimed in claim 4. Kaiser teaches a multiple layer electrode that includes multiple layers of catalyst (abstract). Although Kaiser does mention that diffusion layer in the electrode may be formed of “carbon fiber paper or cloth” (paragraph [0003]), Kaiser, as cited by the Examiner, does not disclose, teach or otherwise suggest the specific structure of the that the diffusion layer claimed in claim 4. In particular, Kaiser does not teach, disclose or otherwise suggest that the anode diffusion layer comprises “a carbon-based material having a contact angle with water of not more than 90° by performing a hydrophilic treatment.” Kaiser also fails to teach a layer on the a carbon-based material wherein the layer is also part of the diffusion layer and has “carbon particles having water absorption amount at saturated water vapor pressure at 60°C of not less than 150 cc/g and fluorine resin” and “wherein water absorption ratio of the anode diffusion layer at 60°C is in a range of 40 to 85%, wherein penetration resistance measured by a penetration resistance method is not more than 5 mΩ, wherein a differential pressure of

the anode diffusion layer measured by the differential pressure measuring method is in a range of 60 to 120 mmAq, and wherein a ratio of quantity of electric charge of catalytic material of the cathode catalytic layer existing in proton conductive passage from the polymer electrolyte membrane measured by a cyclic voltammetric method is not less than 15% of the quantity of electric charge of all the catalytic material existing in the cathode catalytic layer.” The Applicants respectfully submit that Haridoss, Fukuda and Kaiser, either independently or in combination, fail to teach or suggest at least an anode diffusion layer as claimed in claim 4, much less the other features of that diffusion layer specifically claimed in claim 4.

For at least these reasons, Haridoss, Fukuda and Kaiser, either independently or in combination, do not teach or suggest all of the features of newly amended independent claim 4. Accordingly, the Applicants respectfully requests that the 35 U.S.C. § 103(a) rejections of the Office Action of June 30, 2008 relating to this claim be withdrawn.

Claim 5 was rejected under 35 U.S.C. § 103(a) as being unpatentable over Haridoss, Fukuda, Kaiser, Saito and Matsubara. The Applicants respectfully traverse this rejection, insofar as it applies to newly amended claim 5, because Haridoss, Fukuda and Kaiser, either independently or in combination, fail to teach each and every feature of newly amended independent claim 5. For example, newly amended independent claim 5 recites, amongst other features, “an anode and a cathode each having a catalytic layer and a diffusion layer,” where the anode diffusion layer further comprises “a carbon-based material” with “layer thereon containing carbon particles and fluorine resin” and “wherein water absorption amount at saturated water vapor pressure

at 60°C of the carbon particles of the anode diffusion layer is not less than 150 cc/g and water absorption amount at saturated water vapor pressure at 60°C of the carbon particles of the cathode diffusion layer is less than 150 cc/g, wherein water absorption ratio of the anode diffusion layer at 60°C is in a range of 40 to 85%, wherein a differential pressure of the anode diffusion layer and the cathode diffusion layer measured by the differential pressure measuring method is in a range of 60 to 120 mmAg and penetration resistance measured by a penetration resistance method is not more than 5mΩ, and wherein a ratio of quantity of electric charge of catalytic material of the cathode catalytic layer existing in proton conductive passage from a polymer electrolyte membrane measured by a cyclic voltammetric method is not less than 15% of the quantity of electric charge of all the catalytic material existing in the cathode catalytic layer.” The Applicants respectfully submit that Haridoss, Fukuda, Kaiser, Saito and Matsubara, either independently or in combination, fail to teach or suggest at least an anode diffusion layer as claimed in claim 5, much less the other features of that diffusion layer specifically claimed in claim 5.

Haridoss does disclose a membrane electrode assembly MEA in FIG. 6. Once again, the Examiner attempts to make up for the deficiency of Haridoss with respect to the layer on the carbon-based material having carbon particles, fluorine resin and with specified water absorption properties by replacing the “carbon fibers,” “carbon paper or cloth” in the GDL of Haridoss by catalyst carrying carbon black particles of taught in Fukuda. However, as argued above and as Fukuda states explicitly in paragraph [0013] that the carbon black particles have “catalyst metal carried on [their] surfaces.” Again, the catalyst carrying carbon black particles of Fukuda are part of a catalyst layer.

Therefore, replacing the “carbon fibers,” “carbon paper or cloth” in the GDL of Haridoss by carbon black particles of Fukuda does not yield the structure claimed in claim 5. Rather, this replacement proposed by the Examiner yields an anode structure that merely substitutes the “carbon fibers,” “carbon paper or cloth” in the GDL by a catalyst layer. This actually renders the GDL a catalyst layer and eliminates a separate diffusion layer, as claimed in claim 5.

The replacement proposed by the Examiner also intermingles the catalyst with the carbon layer in the Gas Diffusion Layers GDL of the anode and, therefore, results in a device in which there is no separation between the catalytic layer and the carbon-based diffusion layer. In contrast, claim 5 claims a catalytic layer and a diffusion layer in the anode and specifies further that it is the diffusion layer that comprises a carbon-based material with all of the specific structural details claimed in claim 5. This structure claimed in claim 5 is simply not obtained by replacing the “carbon fibers,” “carbon paper or cloth” in the GDL of Haridoss by the catalyst carrying carbon black particles of Fukuda as that replacement does provides no such carbon-based diffusion layer specified in the claim. In fact, this modification, in an attempt to endow the carbon-based diffusion layer of Haridoss with the structure claimed in claim 5, actually replaces the carbon based diffusion layer of Haridoss with a carbon-based catalytic layer and leaves the device of Haridoss without separate catalyst and diffusion layers, as claimed in claim 5.

The Applicants also respectfully submit that none of Kaiser, Saito and Matsubara, as cited by the Examiner, cures the deficiencies of the combination of Haridoss and Fukuda with respect to the anode diffusion layer as claimed in claim 5.

Kaiser teaches a multiple layer electrode that includes multiple layers of catalyst (abstract). Although Kaiser does mention that diffusion layer in the electrode may be formed of “carbon fiber paper or cloth” (paragraph [0003]), Kaiser, as cited by the Examiner, does not disclose, teach or otherwise suggest the specific structure of the that the diffusion layer claimed in claim 5. Saito teaches an electrode for a fuel cell with a catalyst layer including carbon fiber such that the gas diffusion layer is porous (abstract). The Examiner relies on Saito to teach a particular void forming agent for use in the electrode of Haridoss. However, Saito, as cited by the Examiner, does not disclose, teach or otherwise suggest the specific structure of the diffusion layer claimed in claim 5. Matsubara teaches an electrode for a polymer electrolyte fuel cell that, like the device of Saito, includes a catalyst layer including carbon fiber and a porous structure (abstract). The Examiner relies on Matsubara to teach the use of a void forming agent, such as that provided by Saito, in order to improve generation efficiency in the catalytic layer. This is used as the motivation for combining the void forming agent of Saito with the electrode of Haridoss. However, Matsubara, as cited by the Examiner, also does not disclose, teach or otherwise suggest the specific structure of the diffusion layer claimed in claim 5.

In particular, Kaiser, Saito and Matsubara do not teach, disclose or otherwise suggest that the anode diffusion layer further comprises “a carbon-based material” with “layer thereon containing carbon particles and fluorine resin” and “wherein water absorption amount at saturated water vapor pressure at 60°C of the carbon particles of the anode diffusion layer is not less than 150 cc/g and water absorption amount at saturated water vapor pressure at 60°C of the carbon particles of the cathode diffusion

layer is less than 150 cc/g, wherein water absorption ratio of the anode diffusion layer at 60°C is in a range of 40 to 85%, wherein a differential pressure of the anode diffusion layer and the cathode diffusion layer measured by the differential pressure measuring method is in a range of 60 to 120 mmAg and penetration resistance measured by a penetration resistance method is not more than 5mΩ, and wherein a ratio of quantity of electric charge of catalytic material of the cathode catalytic layer existing in proton conductive passage from a polymer electrolyte membrane measured by a cyclic voltammetric method is not less than 15% of the quantity of electric charge of all the catalytic material existing in the cathode catalytic layer."

Further, the Applicants submit that in the presently claimed invention, water generated in the cathode migrates to the anode by a reverse diffusion phenomenon and is retained by the water holding material contained in the water holding layer. When fuel runs short in the anode catalytic layer, the water held in the water holding layer is supplied to the anode catalytic layer, and then the electrolysis of water supplies protons to the cathode. As a result, even under fuel shortage conditions, the electrolysis of water occurs continuously, and undesired carbon corrosion reactions that may occur in subsequent steps of the electrolysis of water may be controlled.

According to the present invention, the differential pressure of the anode diffusion layer is controlled so that water generated from the cathode is retained in the water holding layer. When the differential pressure is lower than the lower limit of the range recited in independent claims 1, 4, and 5, or 60 mmAq, water passes over the water holding layer and cannot be utilized efficiently. When the differential pressure is higher

than the higher limit of the range recited in independent claims 1, 4, and 5, or 120 mmAq, all of the water cannot reach the holding material.

The Applicants submit that only reference Haridoss discusses the measurement of differential pressure, but its teachings differ from that of the present invention. As discussed above, in the present invention, the differential pressure of the anode diffusion layer that includes carbon-based material and the water holding layer is measured. By contrast, in Haridoss, the differential pressure of an aggregate of carbon-based material, a water holding layer, and a catalytic layer are measured. As a result, the differential pressures recited in the present invention and Haridoss are different and cannot be compared directly. Thus, the Applicants submit that none of the cited references teach or suggest a differential pressure range of 60 to 120 mmAq. Moreover, since none of the cited references teach or suggest that the differential pressure of the anode diffusion layer may be controlled to retain water more efficiently, the Applicants submit that the references fail to render obvious the presently claimed invention.

For at least these reasons, Haridoss, Fukuda, Kaiser, Saito and Matsubara, either independently or in combination, do not teach or suggest all of the features of newly amended independent claim 5. Moreover, the Applicants also respectfully assert that dependent claim 6 is allowable at least because of its ultimate dependency on newly amended independent claim 5 and for the additional features that it recites. Accordingly, the Applicants respectfully request that the 35 U.S.C. § 103(a) rejections of the Office Action of June 30, 2008 relating to these claims be withdrawn.

Conclusion

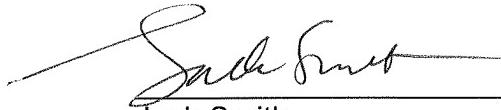
For all of the above reasons, it is respectfully submitted that claims 1-6 are in condition for allowance and a Notice of Allowability is earnestly solicited.

Should the Examiner determine that any further action is necessary to place this application into better form, the Examiner is invited to contact the undersigned representative at the telephone number listed below.

In the event this paper is not considered to be timely filed, the Applicants hereby petition for an appropriate extension of time. The Commissioner is hereby authorized to charge any fee deficiency or credit any overpayment associated with this communication to Deposit Account No. 01-2300 referencing client matter number 108421-00117.

Respectfully submitted,

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